Hessian troops. It was first announced in England two years ago by Miss E. A. Ormerod, consulting entomologist of the Royal Agricultural Society, and it has proved more or less injurious. It has rapidly extended during the past two years, so that now it is found on most portions of the eastern coast, extending up into Scotland. In North America it has spread over the entire wheat-producing country, having appeared in California during the past three years. Dr. Riley thinks that all the evidence points to the importation of the Hessian-fly into England from the continent of Europe, and not from America. He is also of the opinion that on account of the cooler summers and milder winters, and the lateness at which wheat is sown in England, there is very little danger that the crops will be injured there to any such extent as in America and in portions of continental Europe. In fact, it is very injurious only under conditions where two generations are pretty likely produced in the same year; and he is satisfied that in England, as a rule, only one generation will be produced.

The third of the insect pests of which Dr. Riley spoke was the hop-plant louse, *Phorodon humuli*, of which the full life-history has been learned within the past year. It hibernates at the present season of the year. The little glossy, black, ovoid eggs of the species are found attached to the terminal twig, and especially in the more or less protected crevices around the bud, of different varieties and species of plums, both wild and cultivated. From this winter egg there hatches a stem-mother, which is characterized by being somewhat stouter, with shorter legs and honey-tubes, than in the individuals of any other generation. Three parthenogenetic generations are produced upon plums, the third becoming winged. This instinctively flies to the hop-plant, which is entirely free from attacks during the development of the three generations upon plums. A number of parthenogenetic generations are produced upon the hop, until in autumn, and particularly during the month of September, winged females are again produced. This is the pupifera or return migrant, and she instinctively returns to the plum. Here she at once settles, and in the course of a few days, according as weather permits, produces some three or more young. These are destined never to become winged, and are true sexual females. Somewhat later, on the hop, the true winged male, and the only male of the whole series, is developed; and these males also congregate upon the plum, on the leaves of which, towards the end of the season, they may be found pairing with the wingless females which stock the twigs with the winter egg. Twelve generations may be produced during the year, but there is great irregularity in the development of these generations, and the return migrant from the hop is produced at the end of the season, whether from individuals of the fourth or fifth generation, or of the twelfth. Each parthenogenetic female is capable of producing one hundred young (the stem-mother probably being more prolific), at the rate of one to six, or an average of three per day, under favorable conditions. Each generation begins to breed about the eighth day after birth, so that the issue from a single individual runs up easily, in the course of the summer, to trillions. The progeny from a single stem-mother may, under favoring circumstances, blight hundreds of acres in the course of two or three months.

The exact knowledge thus gained, said Dr. Riley, simplifies the protection of the hop-plant from *Phorodon* attack. He suggested destroying the insect on the cultivated plum in early spring, and the extermination of the wild-plum trees in the woods. The introduction of the pest into new hop countries in the egg state upon plum cuttings or scions may be avoided. Infection from one hop-yard to another never takes place.

ELECTRICAL SCIENCE.

Electrical Energy from Carbon without Heat.

A FEW years ago Mr. Willard E. Case brought forward a battery in which an electric current was generated without the consumption of the elements of the cell, the energy being derived from some external source of heat. The electrodes were tin and platinum immersed in a solution of chromic chloride, which, at ordinary temperatures, has no action on the plates. If the cell be heated, "part of one of its elements, chlorine, leaves the chromic chloride, goes over and temporarily combines with the tin, forming a proto-chloride of tin." This action generates an electric current with an electro-motive force of about .3 of a volt. When the cell is allowed to cool, the tin crystallizes out again, and the cell is as it was before. We have, then, a current of electricity the energy of which is obtained from the source of heat applied to the cell, the possible efficiency of the arrangement being fifteen or sixteen per cent. For many reasons this cell cannot be practically used; but Mr. Case has pursued the general subject, and, in a paper lately read before the Institute of Electrical Engineers, he has brought forward some extremely interesting and suggestive experiments. It is probable that the ultimate sources from which electrical energy will be derived are natural sources of power, — waterfalls, etc., and coal; the conversion in the latter case being direct. For the former a perfected storage-battery is necessary; for the latter, some means of oxidizing the coal without the production of heat, the energy being converted directly into electric currents. Mr. Case's experiments in the latter field are as follows: "In a glass cell containing sulphuric acid C.P. (specific gravity 1.81, temperature 75° F.) two electrodes were immersed, — one of platinum, the other of lump graphite. Only a slight electro-motive force was indicated, .007 of a volt, due to the combination, the graphite acting as the positive element. On the addition of a small quantity of chlorate of potassium to the acid, the electro-motive force immediately rose to .8 of a volt, the graphite being disintegrated after a time. This cell polarized rapidly, which was partially prevented by mechanical means. . . . A method of exclusion was adopted to ascertain the oxidant of this electrolyte: chlorine peroxide ($Cl\,O_2$) appeared to be the only active agent. It is decomposed by the carbon, chlorine being evolved with some oxygen. It was assumed that in this cell graphitic acid ($C_{11}H_4O_5$) was formed as the result of the chemical actions." Different forms of carbon were tried in the cell, giving a different electro-motive force for each form, varying from .3 of a volt to 1.25 volts.

Mr. Case sums up the results as follows: "Undoubtedly the direction of experiments in the future will be to find some cheap substance which will absorb oxygen from the air and give it up to the carbon; in fact, acting as a carrier of oxygen, so oxidizing it without heat. And this is not improbable, as we already know of substances which do this, though giving a low electro-motive force: thus, for instance, the ferric salts are reduced to ferrous by agitating their solutions with carbon, being regenerated by absorbing oxygen from the air. By pursuing this line of investigation, we can be sure we are not ignorantly striving against any law of nature when attempting to convert the whole potential energy of carbon into electrical energy."

If we take the energies of combination of different substances as indicating approximately the electro-motive force obtainable from the action, we will find, in looking at the tables giving energies corresponding to various chemical actions, that the greatest electro-motive force we can hope for with batteries in which metals are consumed does not exceed three or four volts. With the hydrocarbons it is different: the energy in some cases is very great; and a battery in which part of the action consists of the formation of some hydrocarbon, or the change from one hydrocarbon to another, might give a much greater electro-motive force than any battery with which we are acquainted. It is very probable that some one will discover a practicable battery of the type Mr. Case has pointed out.

MAXIMUM EFFICIENCY OF INCANDESCENT LAMPS. — Two things are very well known about incandescent electric lamps: their efficiency increases as we increase the current through them, and their brilliancy, and their life decreases from the same causes. There are two items of cost in electric lighting, — the cost of the current supplied to the lamp, and the cost of renewal of the lamps themselves. By running lamps at a very high candle-power, we decrease the amount of current required per candle, but our bill for breakage of lamps is correspondingly increased. Now, it is evident that if we know the cost of the current and lamps, and the life of lamps corresponding to different efficiencies, we can calculate the least expensive way to run our lamps. This Mr. Howell has done in an excellent paper read before the American Institute of Electrical Engineers. He has obtained, in the first place, the efficiency of certain Edison lamps corresponding to different candle-powers

at which they are burned. From another long series of experiments he finds the life of the lamps corresponding to the different efficiencies. With these results, and assuming different prices of current and lamps, Mr. Howell plots curves representing the total cost of operating one hundred sixteen-candle power lamps for one thousand hours; the points of the curves being obtained by varying the efficiency at which the lamps are run, and calculating the total cost from the data he has obtained and assumed. These curves give a definite minimum corresponding to some definite efficiency, the latter varying with the price of current and lamps. These curves are important, as they enable us at once, knowing how much the current costs, to select lamps that will give the best results. On comparing the cost of lamps with the total cost, Mr. Howell finds that in every case the total cost is a minimum when the cost of lamps is about fifteen per cent of the total cost, — a curious and important result.

Electric Lighting and Insurance. — A reduction in insurance rates, where electric lights are exclusively used, has just been voted by the New England Insurance Exchange. The reduction is, however, only allowed where the rules of the exchange are followed in installing the plant, and where the company whose apparatus is used shall pay "any sum assessed as its proportion to defray the cost of inspection." This move has several things to recommend it: it gives to electric lighting the advantage which its superior safety warrants, and it insures the careful installing and regular inspection of the plant. It is in this last that the benefit is greatest. The few fires for which electric lighting is responsible have been the result of cheap and careless work, and with efficient inspection this is impossible. With the wires and appliances that can be purchased to-day, electric lights can be put in buildings in a way to make accident impossible, and electricians can thank their own ill-advised 'economy' for the ill repute in which some people hold the system.

The De Bernado Accumulator. — It is possible that in the final perfected type of accumulator, different patterns will be used for different purposes. At present the 'grid' type of battery-plate used for lighting-purposes is much thicker and heavier than that used for traction-work. It has long been acknowledged, that, where a very heavy current is to be taken from a cell, the Planté form of plate is preferable to the former, in which the active material is pasted into perforations in cast-lead plates; and there seems a tendency, especially in France, to return to some modification of Planté's original idea. De Bernado requires in his welding process a heavy current of electricity; and to obtain it he has devised a new form of accumulator, which will stand the discharge rate required without any very rapid deterioration. The cell does not differ greatly from the Kabath accumulator, which attracted attention some years ago, but which is now little used. The plate consists of a frame of lead, with lead strips passing from one side to the other of the framework. The alternate strips are corrugated obliquely to give circulation, and all of them are burned at their ends to the frame. The plates so made are 'formed' by the Planté process; that is, by reversing the direction of the current passing between two sets of plates immersed in sulphuric acid, at intervals, until an 'active' coating of sufficient depth is produced. There is nothing especially new about this battery, — it differs but little from the Kabath accumulator, — but it is of interest as indicating the gradual return to the original Planté form, or some modification of it, that is gradually taking place, especially where rough usage is necessary.

HEALTH MATTERS.

Lung-Expansion and Consumption.

Dr. Thomas J. Mays of Philadelphia, in a paper read before the Philadelphia County Medical Society, still further elaborates the theory which he has repeatedly expressed, and to which *Science* has before referred. This theory is, that an insufficient expansion of the lungs, especially of their apices, has more to do with the development of consumption than the breathing of impure air, and that, for the prevention of the disease, complete expansion of these organs is more important than the breathing of pure air. The title of his paper is 'Apex-Expansion *versus* Pure Air in Pulmonary Consumption.'

Although Dr. Mays acknowledges that wholesome air is of value in the prevention and treatment of consumption, still he is convinced that the purity of the atmosphere plays but a small part in the result. He cites the almost complete exemption from pulmonary consumption of the inhabitants of Iceland, Greenland, and Lapland, whose habitations are notoriously wanting in ventilation, as proof that this disease is not the result of breathing a vitiated and impure atmosphere. On the other hand, people living in tropical regions, who are out of doors most of the time, are by no means free from consumption. Miners and laborers in coal-mines, although continually respiring an atmosphere loaded with impurities, and damp and musty, suffer but very little from this disease.

That which has been an important factor in establishing the belief that pure air is such an essential element in limiting the ravages of consumption, is that those who occupy elevated or mountainous regions are less liable to this disease than those who live near the sea-level. In reference to this fact, Dr. Mays says that it is estimated that at an elevation of six thousand feet the surface of the body is relieved of nearly seven thousand pounds' pressure. When such an enormous weight is lifted from the body, it is quite evident that its interior must also be markedly affected: the pulse is accelerated from fifteen to twenty beats per minute; the respiration is quickened from ten to fifteen breaths per minute; and evaporation from the skin and lungs is increased. These are some of the immediate effects. Protracted residence in such a high region enlarges the chest capacity. The Quichua Indians, who dwell on the elevated tablelands of Peru, have enormous-sized chests, containing capacious lungs with large air-cells. The Mexican Indians possess chests which are out of proportion to the sizes of the individuals. Dr. Denison says that children born in the Rocky Mountains have chests of unusually large capacity, and M. Jaccoud states that at St. Moritz the respirations are not only more frequent, but fuller.

The reason why the number of respirations increases while ascending a high elevation becomes clear when we take into consideration the fact that at the sea-level a cubic foot of dry air contains about 130 grains of oxygen, while at an elevation of six thousand feet it contains only about 106 grains, — nearly twenty-five per cent less than the body is accustomed to breathe at or near the seaboard.

Professor Mosso has recently proven experimentally that man possesses a lung capacity which is nearly one-fourth larger than the actual necessities of life at the sea-level demand; hence by employing his whole lung capacity he can extract a sufficient amount of oxygen from this attenuated atmosphere without difficulty. And herein lies the secret why so many consumptives, and others with weak lungs, derive such a great benefit when they resort to a mountain climate. Every available space in the chest is brought into requisition to furnish the needed amount of oxygen, the apices are called out of their lethargic state, and the alveoli are inflated; and, if the infiltrated areas are not dispersed, the surrounding alveoli are kept permeable, and so the disease is at least limited, and called into abeyance.

In concluding his paper, Dr. Mays says, "Now, after reviewing the whole subject, we are driven to the conclusion that the line of immunity from consumption, which in the early history of our country was located at the Atlantic seaboard, and which has gradually receded westward with the tide of civilization, until at present it has reached the latitude of Colorado, will not stop in its course until it touches the shores of the Pacific; that the question of curing the disease does not depend on the purity or freshness of the air, or upon the number of bacilli which the atmosphere may contain, or upon the amount of oxygen which may be introduced into the body, for these are all secondary considerations; but it is simply a mechanical question, — a question as to the best mode of expanding the lungs, and especially the apices of our round-shouldered and flat-chested patients, of removing the infiltrated products already existing, and of enhancing the constitutional resistance."

Leprosy in America. — The recent cases of leprosy in Philadelphia have been the means of awakening a new interest in that loathsome disease. Dr. Charles W. Allen, in the *New York Medical Journal*, gives a most complete account of the disease, and the views of the best authorities regarding its communicability.